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Adhesion of a persistent pupillary membrane to the cornea in the eye of a cat.

By E. Treacher Collins.

(With Plates XIII, XIV, XV.)

Adhesion to the back of the cornea of a piece of persistent pupillary membrane has been observed several times clinically. Cases have been described by Beck (1) (1838), Samelsohn (2) (1880), Makrocki (3) (1885), Zirm (4) (1890), Vossius (5) (1893), and others. In our *Transactions* there is an excellent picture showing the appearances of this condition in a case recorded by Silcock (vol. xv, 1895).

So far as the writer knows there are only four cases in which a microscopical examination of the condition has been reported: by Wintersteiner (6) in 1893, by the writer in 1894 (7), by von Hippel in 1905 (8), and in the same year by A. J. Ballantyne, who met with it in a fœtus which was removed post-mortem from the uterus, and who read a paper before this Society in which he discussed the whole subject very fully (vol. xxv, 1905).

There has been considerable difference of opinion as to the causation of these adhesions, and there is still some uncertainty as to whether it is the same in all cases. The record of the following case, in which the adhesion was met with in a cat's eye, may help to elucidate this matter.

A cat about a year old was found to have on the posterior surface of the cornea in its right eye, at about the centre of the line of junction of its upper and middle thirds, a small, irregularly circular, pigmented patch. Proceeding backwards from this pigmented patch, across the anterior chamber to the anterior surface of the iris,

were a number (fifteen to twenty) of delicate thread-like attachments. They varied considerably in thickness; some were so delicate that they could hardly be seen without magnification, others were much stouter and were pigmented like the iris, showing also in places a reddish hue, suggesting that they contained blood-vessels. The position where they joined the iris corresponded to its small circle, a little distance external to the pupillary border. Some of them seemed to be prolongations forwards of the teeth-like processes forming the notched margin of the small circle. Many of the fibres started from the iris by several roots which united to form one. Some just previous to joining the cornea split up into several finer filaments. In all other respects the eye appeared normal.

The cat was killed with chloroform; the right eyeball was removed and hardened in formol. Afterwards it was frozen and divided into two by an antero-posterior vertical section. The section passed through the pigmented patch behind the cornea, some of the filaments uniting it to the iris being in one half and some in the other. The front part of one half was embedded in celloidin and cut into microscopical sections; the other half was embedded in glycerine jelly and preserved as a macroscopical specimen (Pl. XIII, fig. 1).

Microscopical examination.—Sections have been obtained of the filaments passing between the iris and cornea in the whole of their course, but no individual section shows a filament continuous all the way between these two structures.

The filaments start from the anterior surface of the iris a short distance from its pupillary margin and are composed of narrow bands of tissue having the same characteristics as its stroma, of which they appear to be prolongations forwards (Pl. XIII, fig. 2). Their external surface is covered, like the external surface of the iris, by a layer of exceedingly flattened endothelial cells. They contain well-developed blood-vessels, the lumina of which are patent, but their main substance is a tissue like the stroma of the iris, consisting of pigmented and unpigmented

PLATE XIII.

Illustrates Mr. E. Treacher Collins's paper on Adhesion of a Persistent Pupillary Membrane to the Cornea in the Eye of a Cat (p. 203).

Fig. 1.—Showing the lateral half of a cat's eye from which the lens has been removed. Persistent tags of the pupillary membrane stretch from the anterior surface of the iris to the back of the cornea.

Fig. 2 shows the microscopical appearances of a section through the pupillary border of the iris, with a tag of pupillary membrane starting from its anterior surface.

From a photograph by Mr. E. Collier Green.

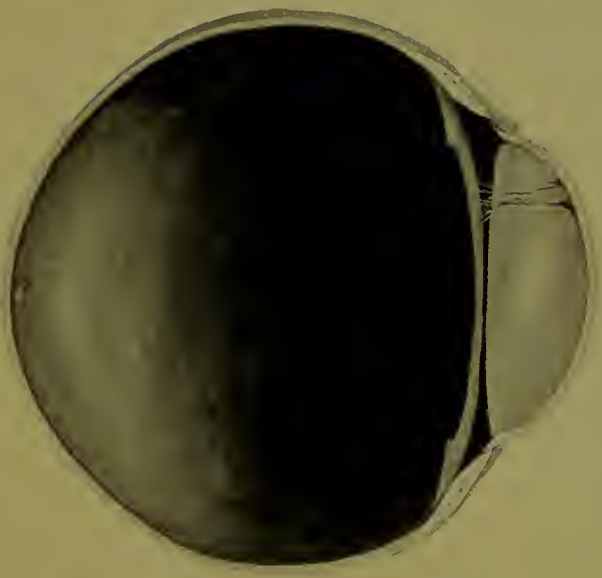

Fig. 1.

Fig. 2.

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PLATE XIV.

Illustrates Mr. E. Treacher Collins's paper on Adhesion of a Persistent Pupillary Membrane to the Cornea in the Eye of a Cat (p. 203).

From photomicrographs by Mr. E. Collier Green.

Fig. 3 shows a section through the cornea, with the plaque of pigment tissue adherent to its posterior surface, and the anterior termination of one of the tags of pupillary membrane.

Fig. 4 shows a section through the posterior part of the cornea, with the pigmented tissue adherent to it. In the gap in the centre of the pigmented tissue Descemet's membrane is present.

Fig. 3.

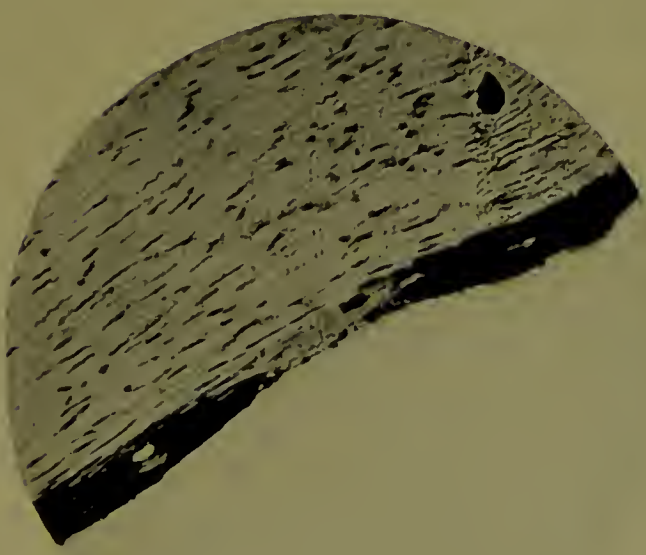

Fig. 4.

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PLATE XV.

Illustrates Mr. E. Treacher Collins's paper on Adhesion of a Persistent Pupillary Membrane to the Cornea in the Eye of a Cat (p. 203).

From photomicrographs by Mr. E. Collier Green.

Fig. 5 shows a section through the posterior part of the cornea and the way in which Descemet's membrane terminates at the margin of the pigmented tissue.

Fig. 6 shows a bleached section of the pigmented tissue on the posterior surface of the cornea and the way in which it replaces Descemet's membrane, and is directly continuous with the substantia propria.

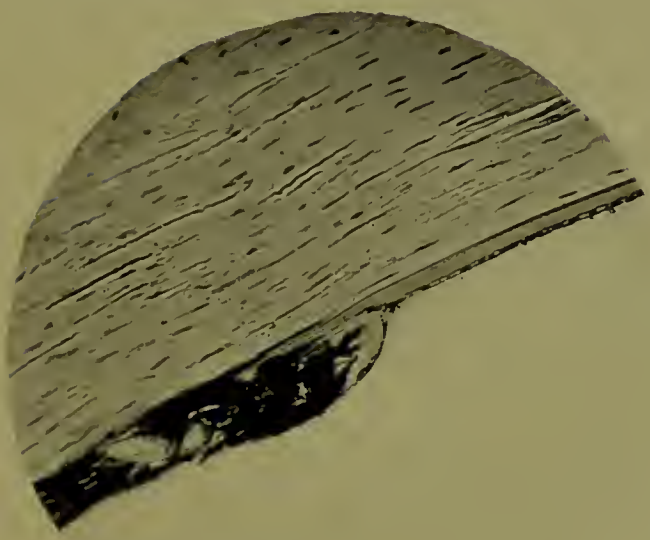

Fig. 5.

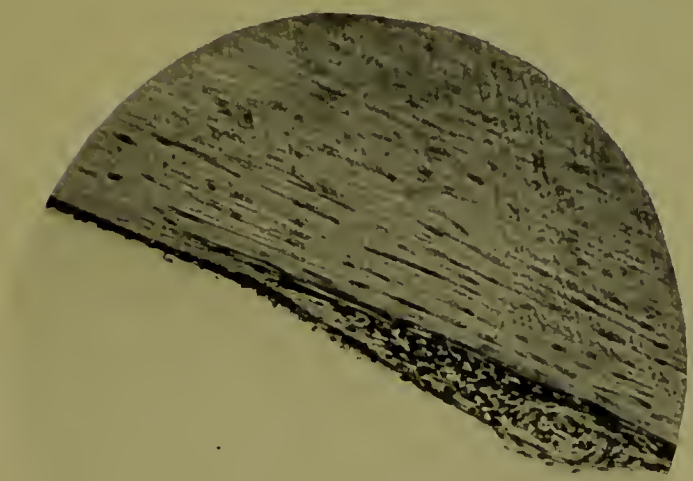

Fig. 6.

Adlard & Son, Impr.

cells, the former predominating in number and containing a quantity of fawn-coloured pigment.

The tissue of the filaments presents the above characteristics throughout their whole course; they do not show, nor does the iris from which they spring show, any round-cell infiltration or anything suggestive of the remains of past inflammatory infiltration. After starting from the iris a filament is seen to gradually taper off and become narrower in its passage across the anterior chamber; it widens out again, however, on approaching its union with the posterior surface of the cornea.

Where the filaments join the cornea is a plaque of densely pigmented tissue, more deeply pigmented than that which composes the filaments themselves. It extends over an area on the back of the cornea more extensive than that occupied by the mere insertion of the filaments (Pl. XIV, fig. 3). The pigment in it is darker than that in the stroma of the iris, but not so dark as that in the epithelium on the posterior surface of that structure. In sections, from which the pigment has been removed by bleaching, the tissue on the back of the cornea is seen to be composed of closely-packed small spindle-shaped cells, and to contain blood-vessels with well formed walls and lumen (Pl. XV, fig. 6). Where this tissue is present Descemet's membrane is absent—it seems to replace it (Pl. XV, fig. 5). One section shows a break in the continuity of the pigmented tissue. The gap where this break occurs is filled with a piece of well-developed Descemet's membrane, having the usual hyaline layer and single row of endothelial cells lining it (Pl. XIV, fig. 4).

At the inner border of the patch where one of the filaments joins it Descemet's membrane is continued for a short distance on the side of the filament and then ceases. The endothelium lining the hyaline membrane of Descemet seems to be in continuity with the endothelium on the surface of the filament; the cells of the latter are, however, more flattened and less easily distinguishable than those of the former.

At the outer border of the pigmented patch, where the hyaline layer of Descemet's membrane ends, the spindle-shaped cells begin; this is well shown in the bleached sections (Pl. XV, fig. 6). Some very flattened endothelial cells, apparently continuous with the endothelium of Descemet's membrane, can be made out on the posterior surface of the patch of spindle cells, that towards the anterior chamber. At its anterior surface the pigmented tissue is in direct continuity with the laminated fibrous tissue of the substantia propria of the cornea. This latter presents its normal characteristics, as also does Bowman's membrane and the surface epithelium. Nowhere do any of these structures show the least irregularity in their arrangement or the least sign of past or present inflammatory infiltration.

In this case the appearance of the filaments passing between the cornea and the iris, together with their position and manner of attachment to the latter, leave no doubt that they must be portions of the pupillary membrane which have failed to disappear. Blood-channels, moreover, have remained patent in the filaments with blood circulating through them. In this respect the case differs from nearly all those of a similar description previously recorded; persistent filaments are generally avascular. In a case recently recorded by von Hippel which was examined microscopically a blood-vessel in the adherent membrane was met with.

The pigmentation of the patch at the back of the cornea in which the filaments terminate is also an exceptional feature. A deep grey opacity in the posterior part of the cornea at the point of adhesion has been mentioned in several cases, but not a pigmented area.

It is conceivable that an adhesion of the pupillary membrane to the back of the cornea might occur in one of two ways: (*a*) The result of inflammation; (*b*) the result of faulty development. In several of the cases recorded there is clinical evidence which is in favour of the adhesion in them being inflammatory in origin. There has in

several been a history of ophthalmia neonatorum and a corneal leucoma was present in some. In a case recorded by Wintersteiner there is pathological evidence of the inflammatory origin, for microscopical examination showed the fresh corneal cicatrix of a perforating ulcer to which the pupillary membrane was attached.

In 1894 the writer published the description of an eye enucleated from an infant, æt. 3 months, in which a definite piece of pupillary membrane was found microscopically to be adherent to the posterior surface of an otherwise perfectly healthy cornea. The endothelium lining Descemet's membrane was absent at the seat of the adhesion; its hyaline layer was normal in appearance as also was the substantia propria, Bowman's membrane, and the anterior epithelium. The eye presented other congenital abnormalities: a persistent and patent hyaloid artery and a mass of fibro-cellular tissue behind the lens (atypically developed vitreous) in which the hyaloid artery broke up. It was this latter which clinically gave rise to a light reflex simulating glioma of the retina and led to the removal of the eye.

The case recorded by Ballantyne was similar to the above, in that microscopically an adhesion was found of a definite pupillary membrane to a cornea which presented nothing abnormal except a defect in the endothelium of Descemet's membrane where the two were united. The vitreous in this eye also contained portions of apparently patent blood-vessels.

Von Hippel has described the microscopical appearances of an adhesion between the pupillary membrane and the cornea in a three day old, not prematurely born, child. It had also double microphthalmos, coloboma, partial iridæmia, cataract, hare lip, cleft palate, polydactylism, and a congenital defect of the skull.

Except at the seat of union of the membrane the appearances of the cornea were perfectly normal, and there was nothing pointing to previous perforation. At the seat of union the fibrous lamellæ of the cornea were

bent slightly outwards, being concave backwards. They gradually merged into the tissue of the adherent membrane, there being no sharp division, only a gradual increase in the number of the nuclei. Descemet's membrane and its lining endothelium were there absent, the hyaline membrane apparently terminating in a point.

In the direct union of the substantia propria of the cornea and the pupillary membrane, and in the presence of a gap in Descemet's membrane, this case, it will be seen, resembles the condition found in the cat's eye described in this paper.

The cases, then, of adhesion of the pupillary membrane to the cornea which have been examined microscopically may be divided into three classes:

(1) A cicatrix of a perforating ulcer of the cornea with the pupillary membrane attached to the scar (Wintersteiner).

(2) A cornea in all respects normal except for a defect in the endothelium on its posterior surface at the seat of attachment of the pupillary membrane (Collins (1), Ballantyne).

(3) A cornea in all respects normal except for an absence of Descemet's membrane and its lining endothelium at the position where the substantia propria and the pupillary membrane become blended (von Hippel, Collins (2)).

The explanation which Ballantyne offers for the condition found in his case is: "That at some period of fœtal life, while iris and pupillary membrane were still closely applied to the cornea, an inflammatory process occurred involving the structures forming the walls of the anterior chamber and leading to destruction, at certain points, of the endothelium. As a result the iris and pupillary membrane came into direct contact with the denuded Descemet's membrane, and 'soldering' or 'glueing' together of these structures took place. There was no permanent new formation of tissue, the inflammatory process undergoing complete resolution."

He thinks also a similar explanation more applicable to the case previously recorded by the writer, than the

view which the latter put forward of the union being due to a failure in the separation of two structures developed from the same mesoblast, namely, the cornea and the pupillary membrane. He says that under such circumstances "an imperfect differentiation of the two tissues" would be expected, and that Descemet's membrane would show a defect at the spot where cleavage had failed to occur.

What von Hippel says, in discussing the cause of the adhesion in his case, applies equally well to the one recorded in this paper.

A previous perforation of the cornea, he writes, is out of the question, unless one assumes complete healing of such a perforation even in the anatomical sense of the word. A simple agglutination caused by a defect in the endothelium does not furnish a sufficient explanation, as there is an organic connection between the membrane and substantia propria of the cornea. There remains as a possible inflammatory origin the occurrence of a small, deep, internal ulcer of the cornea into which the membraen might have healed. Such an explanation, von Hippel says, is exceedingly improbable, as no other traces of any such inflammation can be found in the eye, whereas there are several abnormalities of formation present, the non-inflammatory character of which is absolutely certain.

Finally, he says: "I can, therefore, draw the conclusion that in this particular case it has been proved, almost with complete certainty, that a connection between cornea and membrana pupillaris persistans can be caused by the fact that a separation has not taken place."

In the study of the different changes found in these cases, the writer thinks it will be of interest to recall a few points in the development of the parts in question.*

In sections which he has of the eyes of fœtal mice he finds that after the lens vesicle has become separated from the surface epiblast the space between the two structures

* "The Development of the Posterior Elastic Lamina of the Cornea," E. Treacher Collins, *Roy. Lond. Ophth. Hosp. Rep.*, vol. xiv, p. 305.

is at one stage filled by undifferentiated, round, mesoblastic cells, and that there is no vestige amongst them of any hyaline membrane. In sections of the eye of a human fœtus of between the first and second month he is able to detect in this mesoblastic tissue an exceedingly thin hyaline layer—the commencement of Descemet's membrane. It divides the mesoblastic tissue between the lens and the surface epithelium into two parts: from the anterior, which consists of somewhat elongated cells, is developed the substantia propria of the cornea; from the posterior, which consists of rounder cells, is subsequently differentiated the endothelium of Descemet's membrane and the anterior fibro-vascular sheath of the lens or the pupillary membrane.

If an arrest of development occurred in the formation of a portion of the hyaline layer and in the differentiation of the mesoblastic tissue between the lens and surface epithelium into two parts, a defect in Descemet's membrane and a union of the substantia propria of the cornea and the pupillary membrane would be brought about, such as is met with in von Hippel's case and the one recorded in this paper.

If an arrest of development occurred in the differentiation into endothelium and pupillary membrane of the mesoblastic tissue posterior to the hyaline layer, an absence of endothelium and a direct union of tissue like the pupillary membrane to the hyaline Descemet's membrane would be occasioned, similar to that met with in the first case described by the writer and in Ballantyne's case.

In the absence of all microscopical signs of past or present inflammatory changes in an eye, and in the presence of other congenital malformations (such as the persistence of the hyaloid artery) which can certainly not be inflammatory in origin, the balance of evidence seems to the writer to be strongly in favour of an arrest of development being the cause of the adhesion, rather than inflammation.

He thinks, moreover, that the two cases which he has

examined afford excellent examples of arrest of development at two different stages, as above described.

References.

(1) *Ammon's Monatschrift. f. Med. etc.*, Bd. i, S. 1.

(2) *Centralblatt. f. Augen.*, Bd. iv, S. 215.

(3) *Archiv f. Augen*, Bd. xiv, S. 83.

(4) *Klin. Monatsb. f. Augen.*, Bd. xxviii, S. 290.

(5) *Beiträge z. Augenh.*, Bd. i, S. 709.

(6) *Wien. klin. Wochenschrift*, No. 28, and *Arch. f. Ophth.*, Bd. lvii, H. 1, S. 53.

(7) *Lancet*, 1894, ii, and *Researches into the Anat. and Path. of the Eye*, 1896.

(8) *Arch. f. Ophth.*, Bd. lx, H. 3, S. 444.

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